



# Updates to the EPA Rating for Hotels

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# Agenda

- EPA Ratings
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  - ◆ Technical Foundation
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- EPA Hotel Modeling Results
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- Your Feedback (**thanks!**)
- Key Hotel Issues
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  - ◆ Conference Facilities
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- Questions and Discussion

# EPA Ratings Objective



- Help businesses protect the environment through superior energy efficiency
- Motivate organizations to develop a strategic approach to energy management
- Convey information about energy performance in a simple metric that can be understood by all levels of the organization

# EPA Ratings Objective



- Monitor actual as-billed energy data
- Create a whole building indicator
  - ◆ Capture the interactions of building systems not individual equipment efficiency
  - ◆ Track energy use accounting for weather and operational changes over time
- Provide a peer group comparison
  - ◆ Compare a building's energy performance to its national peer group
  - ◆ Track how changes at a building level alter the building's standing relative to its peer group

# EPA Ratings

## Technical Foundation



- Analyze national survey data
  - ◆ Commercial Building Energy Consumption Survey (CBECS)
- Develop regression models to predict energy use for specific space types based on operations
- Create scoring lookup table
  - ◆ Ratings are based on the distribution of energy performance across commercial buildings
  - ◆ One point on the ENERGY STAR scale represents one percentile of buildings
- Buildings that perform in the 75th percentile or better can earn the ENERGY STAR label

# EPA Ratings

## Technical Foundation



- Develop the regression model
  - ◆ Account for building operations (e.g., Guest Rooms, Employees, Refrigeration, HDD, CDD)
- Apply a linear regression model

$$\text{Energy} = C_0 + C_1 * \text{GuestRooms} + C_2 * \text{Workers} + C_3 * \text{WalkinRefrigeration} + C_4 * \text{HDD} + C_5 * \text{CDD} + \dots$$

- ◆ Coefficients represent average responses
- ◆ Coefficients provide adjustments for each operational characteristic
  - **Does not** add the kWh of each piece of equipment
  - **Does** adjust energy based on correlation between operating characteristic and energy use

# EPA Ratings

## Technical Foundation



- The rating ***does***
  - ◆ Evaluate as billed energy use relative to building operations
  - ◆ Normalize for operational characteristics (e.g., size, number of employees, walk-in refrigeration, climate)
  - ◆ Depend on a statistically representative sample of the US commercial building population
- The rating ***does not***
  - ◆ Attempt to sum the energy use of each piece of equipment
  - ◆ Normalize for technology choices or market conditions (e.g., type of lighting, energy price)
  - ◆ Explain how or why a building operates as it does

# EPA Ratings Example



- EPA ratings identify the percentile of performance for a hotel's EUI ***when normalizing*** for key operating characteristics in the regression equation
- Two example buildings
  - ◆ Same climate
  - ◆ ***Same EUI***
  - ◆ Different operation
    - Large hotel with many rooms and services vs. smaller hotel
  - ◆ ***Different ratings***

# EPA Ratings Example



	Sample Small Hotel	Sample Large Hotel
Square Feet	50,000	450,000
# of Rooms	90	550
Presence of Food Preparation	No	Yes
# of Commercial Refrigeration Cases	2	30
# of In-Room Refrigerators	90	550
# of Workers	18	300
Predicted EUI (kBtu/square foot)	250	355
<b>Actual EUI (kBtu/square foot)</b>	<b>270</b>	<b>270</b>
<b>Rating</b>	<b>39</b>	<b>77</b>

# EPA Ratings Example



- Two example buildings have same EUI but different ratings
- Operating characteristics in model account for differences in operation
  - ◆ Commercial refrigeration and/or cooking
  - ◆ Staffing
  - ◆ Number and density of rooms
- These adjustments are based on statistical correlations
- Statistical correlations reflect different levels of amenities and services
  - ◆ **Not** just the kWh requirement of a worker or in-room refrigerator

# EPA Hotel Modeling Results

## Model Details



- Data: CBECS 2003 survey
- Dependent variable: Source Energy per square foot
  - ◆ Source EUI
- Independent variables:
  - ◆ HDD and CDD
  - ◆ Percent heated and percent cooled
  - ◆ Number of Rooms per square foot
  - ◆ Presence of cooking on-site (yes/no)
  - ◆ Number of commercial refrigeration units
  - ◆ Number of in-room residential refrigerators\*
  - ◆ Number of workers\*
  - ◆ Gross building square foot\*

*\*indicates a variable still under evaluation*

# EPA Hotel Modeling Results

## Model Performance



- Multiple factors to evaluate
  - ◆ Regression model statistics (F, p, R<sup>2</sup>)
  - ◆ Individual variable statistics (t-stats)
  - ◆ Distribution of ratings
    - By 10% bin
    - Average rating
    - Number and percent above 75
    - Partner Data and CBECS data
  - ◆ Residual and rating plots
  - ◆ Partner data evaluation
    - Do partner regressions show similar results?
  - ◆ Physical understanding of results
    - Do variables make sense?
    - Industry feedback
  - ◆ Magnitude of impacts
    - How much does each variable affect the model?
- Best model must show a good balance using all criteria

# EPA Hotel Modeling Results

## Model Performance



- **Model R2 values**
  - ◆ **Expressed relative to Source EUI**
    - R2 = 0.40 to 0.50
    - The model explains 40 to 50% of the variation in EUI
  - ◆ **Expressed relative to total source energy**
    - R2 = 0.8 to 0.9
    - The model explains 80 to 90 % of the variation in total source energy consumption
  - ◆ **The R2 values are strong**
    - High for a statistically based energy model
    - Higher than current Hotel models
    - Higher than some of the other EPA building models

# EPA Hotel Modeling Results

## Model Performance



- **Overall model statistics**
  - ◆ General statistics to evaluate model performance are strong
  - ◆ F-Statistic: 10 to 20
  - ◆ p-level:  $< 0.0001$
- **Individual variable p-levels**
  - ◆ Individual variables can be tested to determine the statistical significance of each adjustment
  - ◆ These are significant with 90% confidence or better
    - p-level of 0.10 or lower
    - t-statistic of 1.68 or higher
- **Strong model**
  - ◆ Based on these statistics, the models appear robust
  - ◆ EPA believes the models offer improvements to our existing capabilities

# EPA Hotel Modeling Results

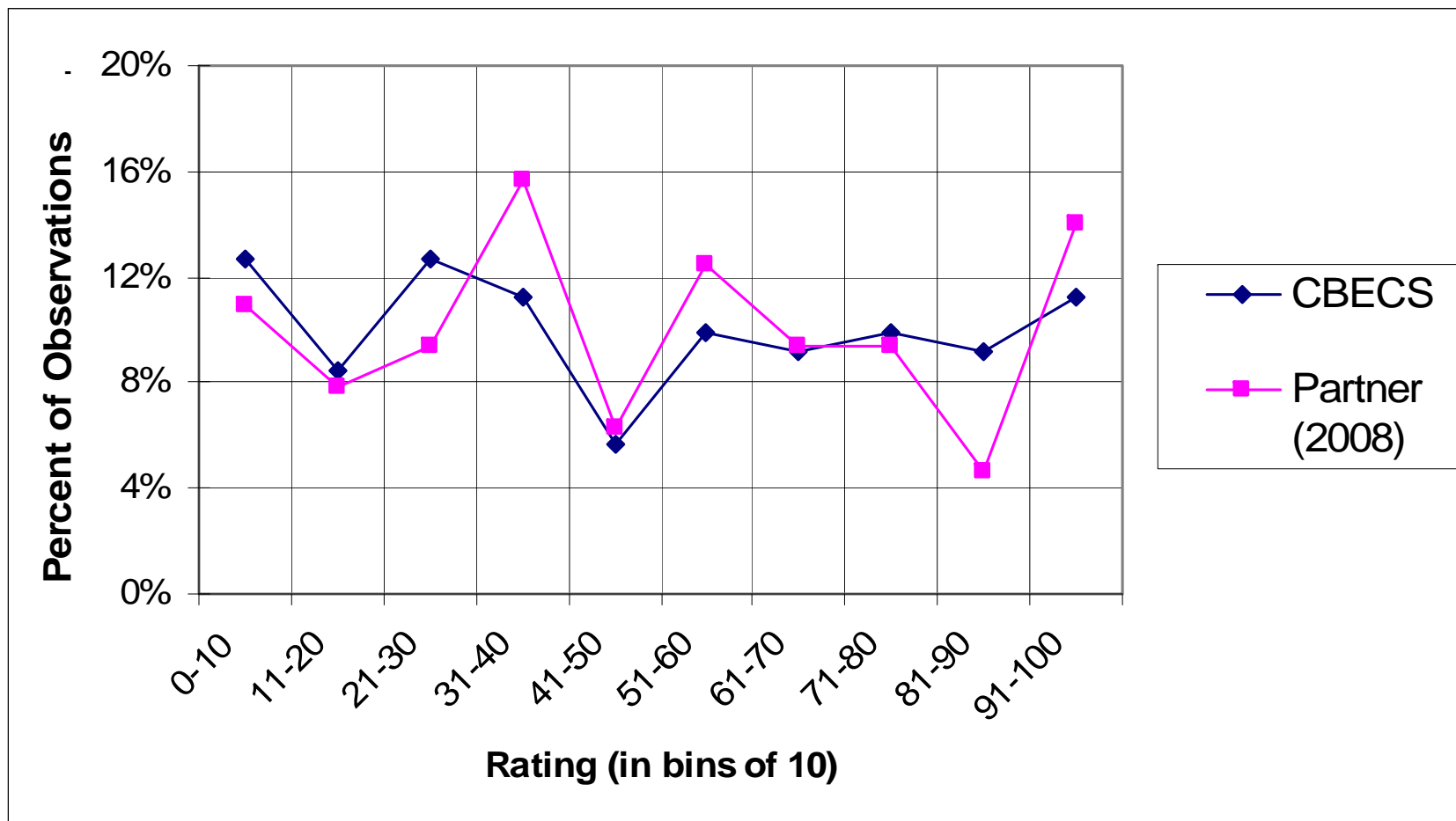
## Model Performance



- Model produces a uniform distribution
  - ◆ Approximately 10% of the CBECS population falls within each 10 point rating bin
  - ◆ Approximately 10% of the Partner data falls within each 10 point rating bin
- Residual plots exhibit random scatter
  - ◆ Buildings with particular operating parameters do not have systematically higher (or lower) ratings
  - ◆ Buildings in different climates do not have systematically higher (or lower) ratings

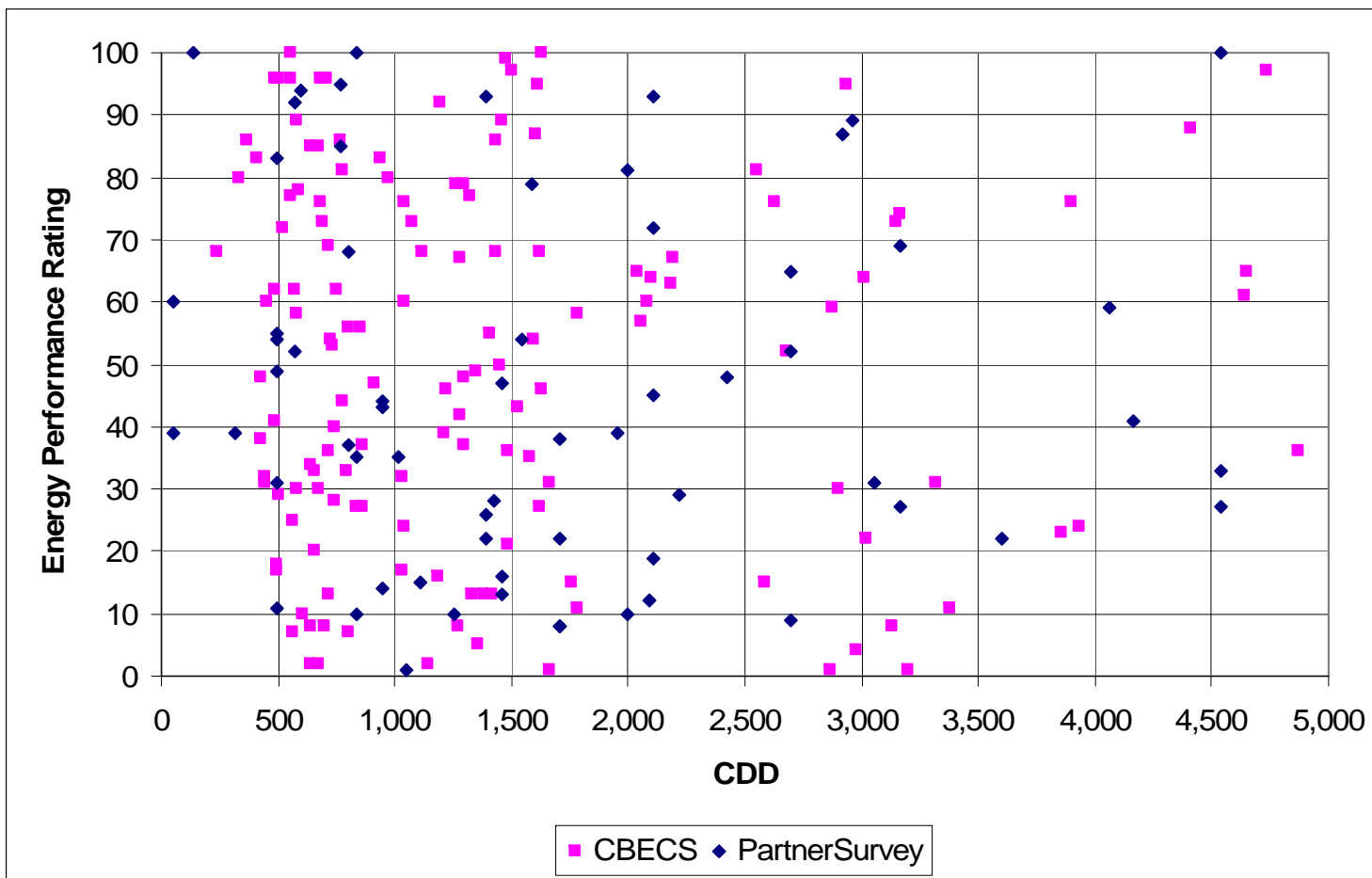
# EPA Hotel Modeling Results

## Model Performance



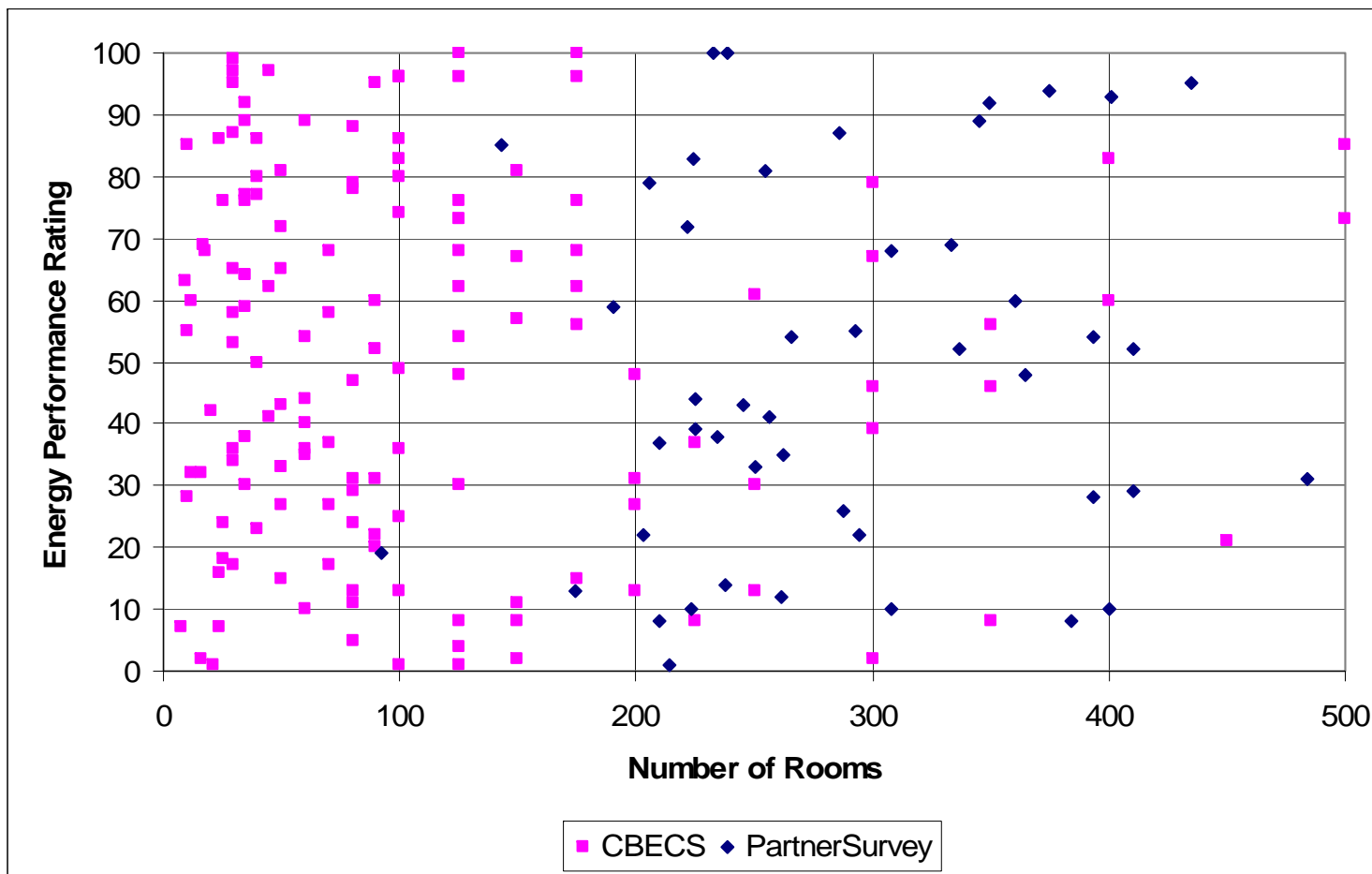
# EPA Hotel Modeling Results

## Model Performance



# EPA Hotel Modeling Results

## Model Performance





# Your Feedback

- Number of servers
  - ◆ Variable is no longer under consideration
  - ◆ Not a significant driver
  - ◆ No clear definition
- Number of workers
  - ◆ Variable is still under consideration
  - ◆ Likely correlated with different levels of service/amenities
  - ◆ Workers may not use a lot of energy directly – but they are related to guest services that do
  - ◆ Consider asking in bins to facilitate data entry
- Optional variables
  - ◆ Laundry facilities
  - ◆ Conference facilities
  - ◆ Even if not in a model, valuable to track for future analyses
- Thank you

# Key Hotel Issues

## Hotel Size



- Definition
  - Gross floor area should be measured from the principle exterior walls for the building(s) of the hotel
  - Gross floor area should **include** all functions within the building (basements, elevator shafts, conference facilities, etc)
  - Gross floor area should **not include** any functions exterior to the building (exterior pool areas, seating areas, walkways)
- Basis of definition
  - Existing definition in CBECS and Portfolio Manager
  - Must maintain consistency
  - Rating focuses on the whole building
- Consistency
  - Different interpretations in other markets, too (especially commercial office)
  - Able to maintain clear language and accurate ratings in Portfolio Manager

# Key Hotel Issues

## Hotel Size



- There is a broad range of hotel size in the industry
  - Buildings in Portfolio Manager generally larger than CBECS
  - Buildings shared by partners in 2008 are much larger than both Portfolio Manager and CBECS populations

	<b>CBECS</b>	<b>Portfolio Manager</b>	<b>Partner (2008)</b>
Hotel Size (Sq. Ft.)	81,656	226,982	469,711
Mean Rooms	111	277	518
Rooms per 1,000 square foot	1.93	1.51	1.21
Mean EUI	205	238	240

# Key Hotel Issues

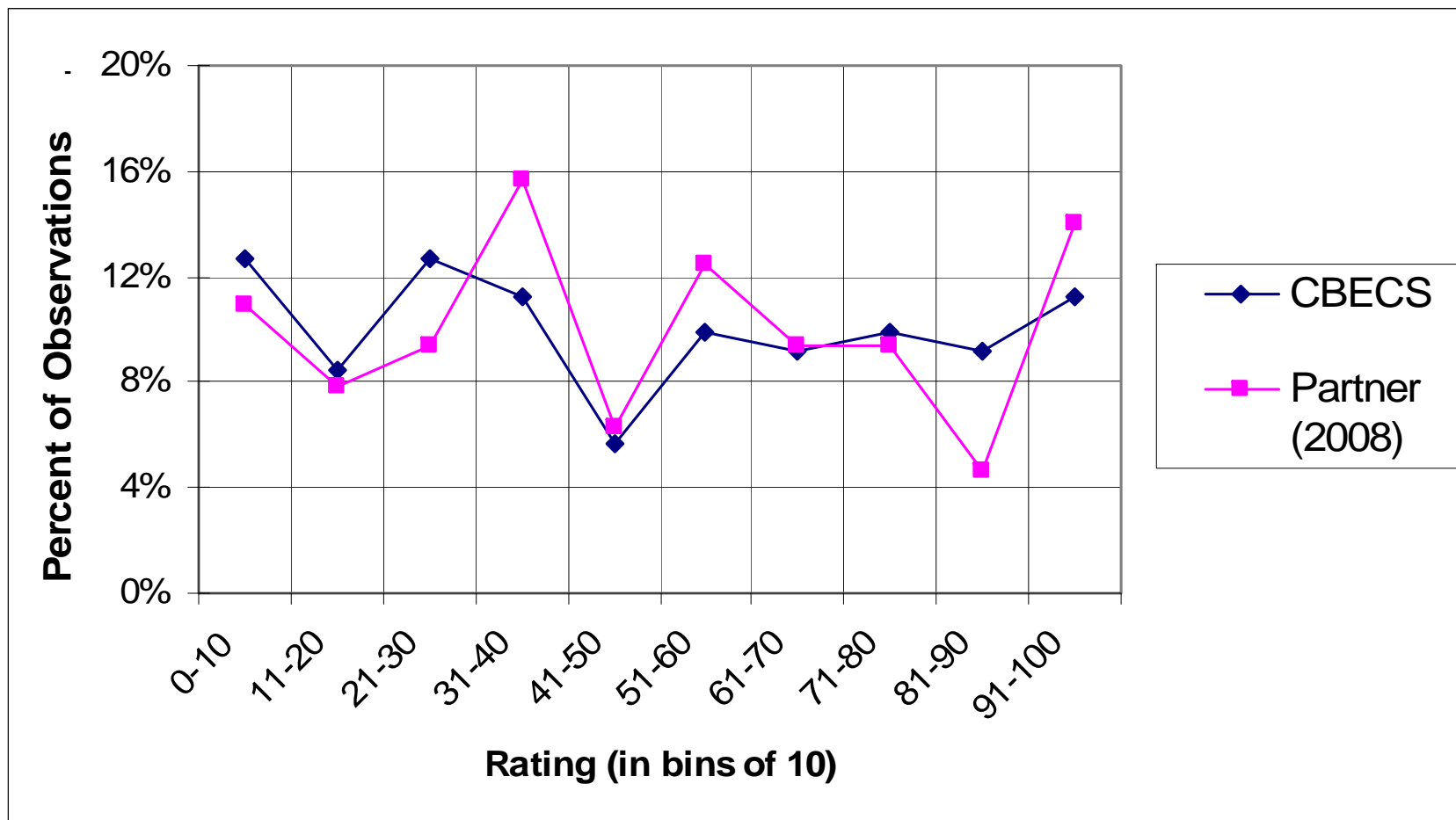
## Hotel Size



- EPA needs a model to address all hotel sizes
  - ◆ National model should be relevant for all segments of the hotel industry
  - ◆ Current models address all sizes of hotels through the amenity categories
- Difference in size of hotels in each data group provide good testing sample for EPA
  - ◆ Distribution of ratings for Partner Data (larger) similar to distribution of ratings for CBECS data (smaller)
  - ◆ Distribution of ratings with respect to key operational parameters for Partner Data (larger) similar to distribution of ratings for CBECS data (smaller)
  - ◆ Distributions suggest model works across broad size range

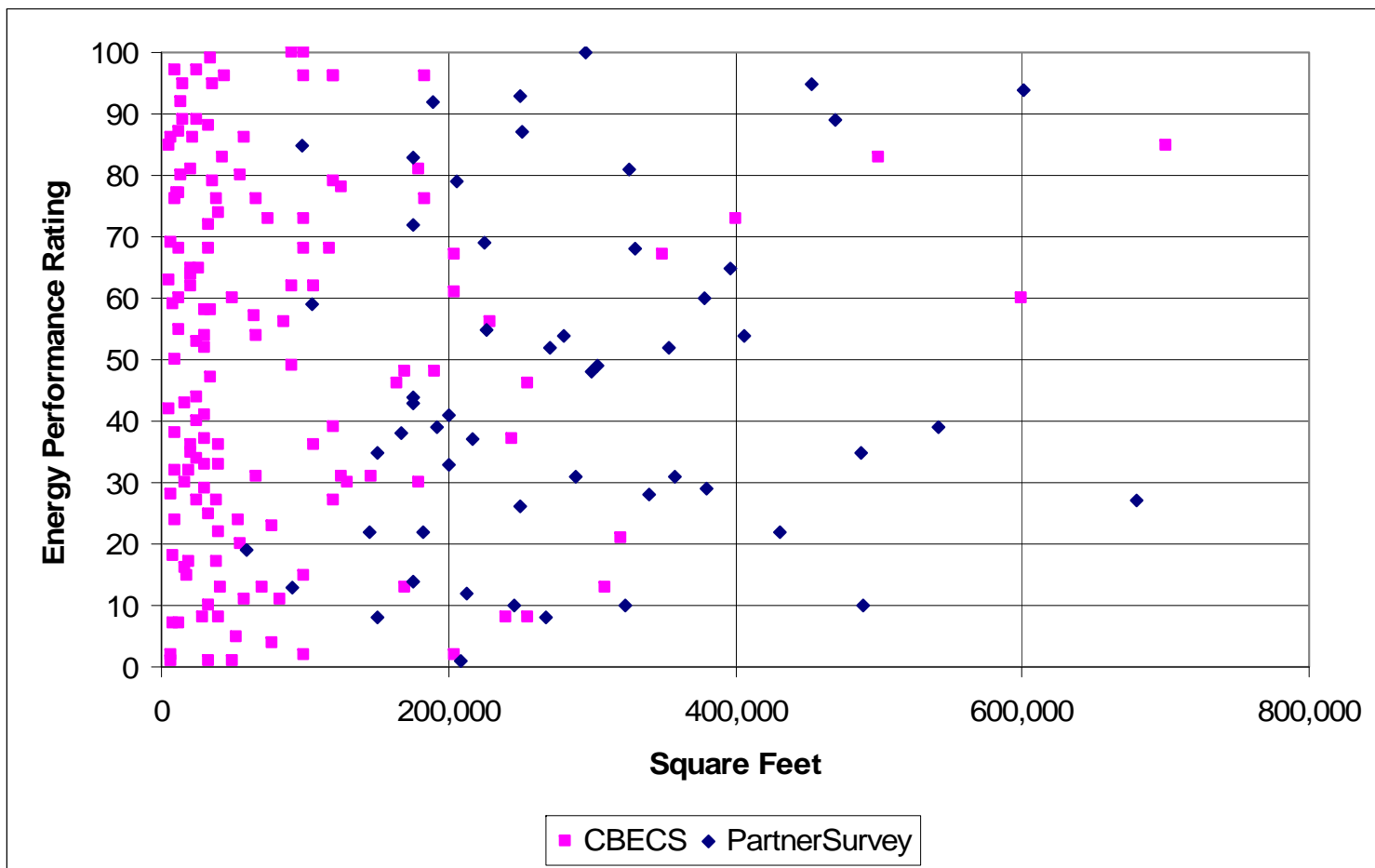
# Key Hotel Issues

## Hotel Size



# Key Hotel Issues

## Hotel Size



# Key Hotel Issues

## Conference Facilities



- Conference space
  - ◆ Integral part of the operation of many hotels
  - ◆ No information collected in CBECS
- Related characteristics
  - ◆ Total building size
  - ◆ Number of rooms per 1,000 square foot
  - ◆ Presence of commercial cooking and/or number of commercial refrigeration units
  - ◆ Number of workers
- Partner data
  - ◆ 95% of the 65 hotels shared with EPA in 2008 indicated the presence of conference facilities

# Key Hotel Issues Conference Facilities



- Requirements
  - ◆ Model that works for facilities with and without conference facilities
  - ◆ Model that is based on nationally representative data
- Model
  - ◆ Accounts for hotel service level and conference space through the use of other variables
    - Size, room density, commercial cooking, commercial refrigeration, staffing
- Performance
  - ◆ 95% of partner supplied hotels have conference space
  - ◆ Smaller CBCES hotels unlikely to have conference space
  - ◆ Similar performance in the CBECS population **and** the partner-supplied data (2008)
    - Flat distribution
    - Similar average rating and percent above 75
  - ◆ No evidence of any bias in the model

# Key Hotel Issues

## Laundry Facilities



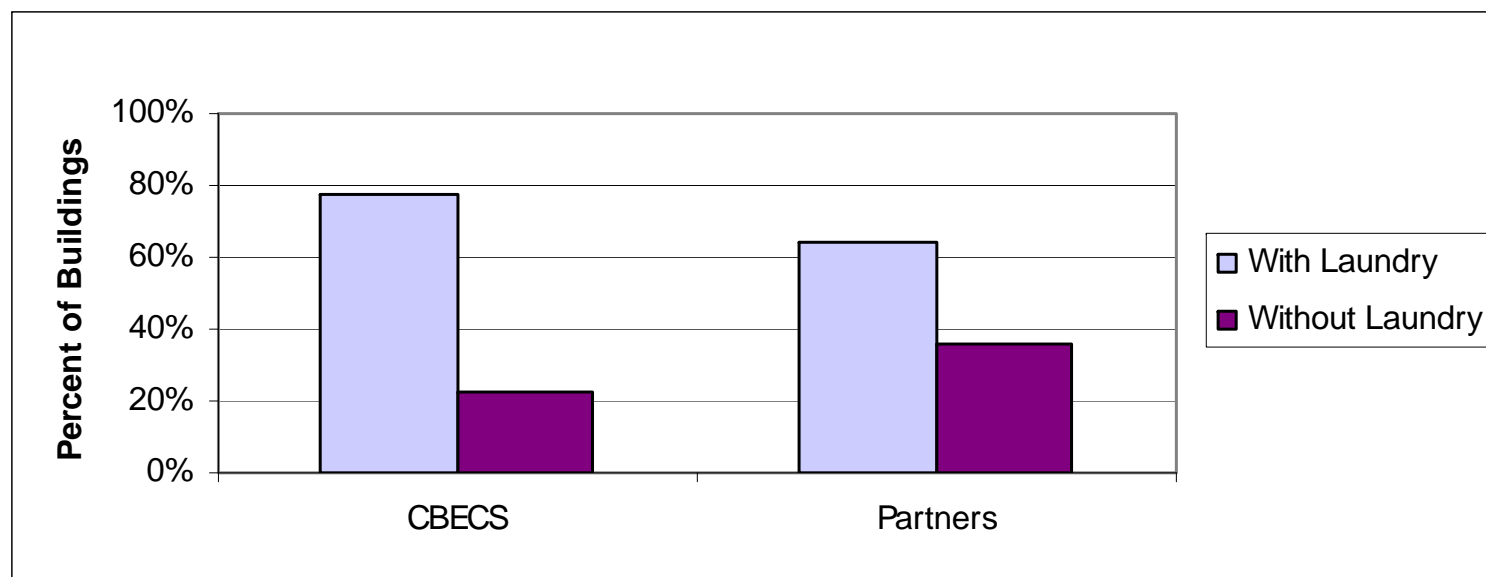
- Prevalence of on-site laundry
  - ◆ 77% of CBECS hotels
  - ◆ 64% of Partner hotels
- Energy use of on-site laundry
  - ◆ Energy per square foot (EUI) for buildings with on-Site laundry similar or **lower** than for buildings without
- Laundry in the model
  - ◆ Not statistically meaningful (CBECS)
  - ◆ Also does not appear with a significant correlation if a regression performed on partner data
  - ◆ No evident bias in CBECS or Partner hotels using models under evaluation

# Key Hotel Issues

## Laundry Facilities



- Both CBECS and Partner data contain a sample of buildings with and without laundry
  - ◆ Able to compare the two populations
  - ◆ Similarity between CBECS and Partner data reinforces conclusions drawn from both populations

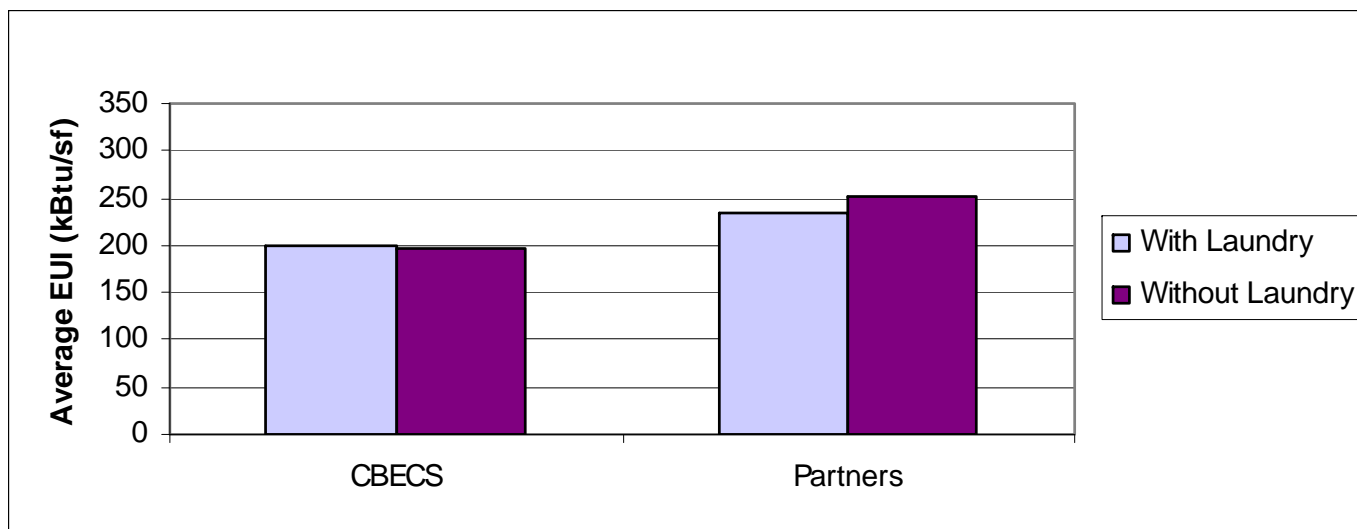


# Key Hotel Issues

## Laundry Facilities



- Little difference in energy consumption for buildings with and without laundry
  - ◆ CBECS buildings have the same average with and without
  - ◆ Partner hotels that have laundry report **lower** EUIs



# Key Hotel Issues Laundry Facilities



- Unexpected result
  - ◆ Cannot always predict the most important factors
  - ◆ Similar analysis for supermarkets and open/closed refrigerated display cases
- Related variables
  - ◆ Laundry use is likely correlated with other aspects of hotel operation
    - Size, number of workers, services and amenities
- Model recommendation
  - ◆ No specific yes/no variable is statistically meaningful
  - ◆ No evident bias in CBECS or Partner data
  - ◆ Incorporate an optional variable to enable future tracking of market trends and significance



# Summary

- Model development
  - ◆ Perform a thorough analysis of CBECS
  - ◆ Incorporate many comparative factors
  - ◆ Assess Portfolio Manager and partner data
- Your feedback
  - ◆ Valuable insight into hotel operations
  - ◆ Incorporate observations into model variable decisions
  - ◆ Determined to add optional variables to enable future analyses
- New model
  - ◆ Strong statistical properties
  - ◆ More variables to account for difference in service level and amenities
  - ◆ Robust with respect to CBECS population **and** your data
  - ◆ Improvement over existing methodologies



# Timeline

- Now and ongoing
  - ◆ Benchmark your facilities in Portfolio Manager
  - ◆ Apply for the ENERGY STAR at hotels with ratings of 75 or higher
- September 22, 2008
  - ◆ Provide any additional feedback to EPA
- October 15, 2008
  - ◆ Provide resort data to EPA
- December 2008
  - ◆ Meeting to share and discuss resort analysis
- January 2009
  - ◆ Revised hotel benchmarking model released



# Questions and Discussion